

CLAIMS

1. Measuring device for electric motors, in particular spindle motors, comprising a motor mount, in which the electric motor to be tested can be positioned on the stator side for the measurement, and a first runout measuring device, which has at least a first runout sensor and with which a runout in a first direction can be sensed on a rotor of the electric motor held in the motor mount, a second runout measuring device which has at least a second runout sensor and with which a runout of the rotor in a second direction, extending transversely in relation to the first direction, can be measured at the same time as the runout in the first direction.
2. Measuring device according to claim 1, wherein the first runout sensor and the second runout sensor are contactless sensors.
3. Measuring device according to claim 2, wherein the first runout sensor and the second runout sensor are capacitive sensors.
4. Measuring device according to claim 3, wherein a carrier frequency of the first runout sensor and a carrier frequency of the second runout sensor operate with a phase shift.
5. Measuring device according to claim 4, wherein the carrier frequency of the first runout sensor and the carrier frequency of the second runout sensor operate approximately in phase opposition.

6. Measuring device according to claim 1, wherein the first runout sensor is mounted on a first sensor advancing unit and can be advanced by this toward the rotor in the first direction.
7. Measuring device according to claim 6, wherein a controller which uses the first runout sensor as a spacing sensor during the advancement of the same toward the rotor is provided for activating the first sensor advancing unit.
8. Measuring device according to claim 7, wherein the controller advances the first runout sensor with the rotor rotating.
9. Measuring device according to claim 1, wherein the second runout sensor is mounted on a second sensor advancing unit and can be advanced by this toward the rotor in the second direction.
10. Measuring device according to claim 8, wherein a second controller which uses the second runout sensor as a spacing sensor during the advancement of the same toward the rotor is provided for activating the second sensor advancing unit.
11. Measuring device according to claim 10, wherein the controller advances the second runout sensor with the rotor rotating.
12. Measuring device for electric motors, in particular spindle motors, comprising a motor mount, in which the electric motor to be tested can be positioned on the stator side for the measurement, and a first runout measuring device, which has at least a first runout sensor and with

which a runout in a first direction can be sensed on a rotor of the electric motor held in the motor mount, the runout measuring device determining for every individual revolution from a multiplicity of revolutions of the rotor in the same rotational positions of the rotor in each case a measured value associated with each individual rotational position for the runout.

13. Measuring device according to claim 12, wherein the ascertainment of the individual rotational positions is performed by synchronization of a trigger signal for the runout measurement by the respective runout measuring device with the rotational movement of the rotor.
14. Measuring device according to claim 13, wherein the synchronization of the runout measurement with the rotational movement of the rotor is performed by the respective runout measuring device without any markings.
15. Measuring device according to claim 14, wherein the synchronization of the runout measurement with the rotational movement of the rotor is performed by sensing the variation over time of the voltage at an electrical terminal of the electric motor by means of a voltage sensing circuit.
16. Measuring device according to claim 15, wherein the voltage sensing circuit senses zero crossings of the voltage at the one electrical terminal of the electric motor.

17. Measuring device according to claim 16, wherein, after sensing a zero crossing, the voltage sensing circuit senses the zero crossing corresponding to the number of poles of the electric motor and indicating the beginning of the next-following revolution.
18. Measuring device according to claim 17, wherein the sensing of the zero crossings respectively indicating a new revolution is used in a phase-locked manner to derive a corresponding trigger signal, by which a subdivision of each revolution of the rotor takes place into a defined number of rotational positions for which a measured value of the respective runout sensor is to be sensed.
19. Measuring device according claim 12, wherein a measured-value acquisition, which acquires the measured values for each individual rotational position that are measured by the respective runout sensor, is provided.
20. Measuring device according to claim 19, wherein the measured-value acquisition forms a mean value from the measured values of the respective runout sensor that are associated with each individual rotational position.
21. Measuring device according to claim 20, wherein the measured-value acquisition determines the maximum difference between the mean values of all the rotational positions of a revolution of the rotor.
22. Measuring device according to claim 20, wherein the measured-value acquisition determines the maximum deviation of the measured values from the mean value for each rotational position.

23. Measuring device according to claim 22, wherein the measured-value acquisition determines the maximum difference between the maximum deviations ascertained in respect of all the rotational positions of a revolution of the rotor.
24. Measuring device according to claim 1, wherein the time-dependently ascertained measured values for the runout are Fourier-transformed by a computer and in that a frequency spectrum resulting from this is evaluated.
25. Measuring device according to claim 24, wherein an analysis of the frequency spectrum corresponding to all the speed-harmonic frequencies is performed.
26. Measuring device for electric motors, in particular spindle motors, comprising a motor mount, in which the electric motor to be tested can be positioned on the stator side for the measurement, a voltage induction measuring device, which measures a voltage induced in the non-energized windings of the electric motor with the rotor running freely.
27. Measuring device according to claim 26, wherein the voltage induction measuring device is connected to the windings via a switching unit and in that the switching unit can be switched in such a way that the induced voltage can be measured directly after energizing of the electric motor is switched off.

28. Measuring device according to claim 27, wherein the measuring device ascertains by means of a computer the amplitude maxima and zero crossings of the induced voltage influenced by reducing the rotational speed of the rotor, and adapts a theoretical profile of the induced voltage to these values and uses this adapted theoretical profile to ascertain the amplitude values of the induced voltage and zero crossings for an unbraked rotation of the rotor.
29. Measuring device according to claim 28, wherein the computer senses the variation over time of the amplitude of the induced voltage by means of an envelope curve adapted to amplitude maxima of the induced voltage.
30. Measuring device according to claim 26, wherein the measuring device has an inductance measuring device and an external stepping motor for driving the rotor, in that the stepping motor can be used to rotate the rotor into individual rotational positions and in that the inductance measuring device can be connected to the winding terminals of the electric motor, so that a measured value of the inductance of windings of the electric motor can be sensed in respect of each rotational position.
31. Measuring device according to claim 26, wherein the measuring device has a stray flux measuring device comprising a stray flux sensor and in that, in a measuring position with the rotor slowing down and without energizing of the same, the stray flux sensor measures a minimum value and a maximum value of the magnetic stray flux at a specifiable location of the rotor.

32. Measuring device according to claim 26, wherein the measuring device comprises a winding resistance measuring device, which measures the resistance of the windings of the stationary electric motor.
33. Measuring method for electric motors, in particular spindle motors, in which the electric motor to be tested is positioned for the measurement on the stator side in a motor mount, a first runout measuring device, having a first runout sensor, is used to sense a runout of a rotor of the electric motor in a first direction, and a second runout measuring device, having a second runout sensor, is used to sense a runout of the rotor in a second direction, extending transversely in relation to the first direction, at the same time as the runout in the first direction.
34. Measuring method according to claim 33, wherein the first runout sensor and the second runout sensor operate with a phase shift.
35. Measuring method according to claim 34, wherein the first runout sensor and the second runout sensor operate approximately in phase opposition.
36. Measuring method according to claim 33, wherein the first runout sensor is used as a spacing sensor during the advancement of the same toward the rotor.
37. Measuring method according to claim 33, wherein the second runout sensor is used as a spacing sensor during the advancement of the same toward the rotor.

38. Measuring method for electric motors, in particular spindle motors, in which the electric motor to be tested is positioned for the measurement on the stator side in a motor mount, a first runout measuring device, having a first runout sensor, is used to sense a runout of a rotor of the electric motor in a first direction, and for every individual revolution from a multiplicity of revolutions of the rotor in the same rotational positions of the rotor, in each case a measured value associated with each individual rotational position is determined for the runout.
39. Measuring method according to claim 38, wherein the individual rotational positions are ascertained by synchronization of a trigger signal for the runout measurement with the rotational movement of the rotor.
40. Measuring method according to claim 39, wherein the synchronization of the runout measurement with the rotational movement of the rotor is carried out without any markings.
41. Measuring method according to claim 40, wherein the synchronization of the runout measurement with the rotational movement of the rotor is carried out by sensing the variation over time of the voltage at an electrical terminal of the electric motor.
42. Measuring method according to claim 41, wherein, for the synchronization, zero crossings of the voltage are sensed at the one electrical terminal of the electric motor.

43. Measuring method according to claim 42, wherein, after sensing a zero crossing, the zero crossing corresponding to the number of poles of the electric motor and indicating the beginning of the next-following revolution is ascertained.
44. Measuring method according to claim 43, wherein the sensing of the zero crossings respectively indicating a new revolution is used in a phase-locked manner to derive a corresponding trigger signal, by which a subdivision of each revolution of the rotor is carried out into a defined number of rotational positions for which a measured value of the respective runout sensor is sensed.
45. Measuring method according to claim 44, wherein a mean value is formed from the measured values of the respective runout sensor that are associated with each individual rotational position.
46. Measuring method according to claim 45, wherein the maximum difference between the mean values of all the rotational positions of a revolution of the rotor is determined.
47. Measuring method according to claim 46, wherein the maximum deviation of the measured values from the mean value is determined for each rotational position.
48. Measuring method according to claim 47, wherein the maximum difference between the maximum deviations ascertained in respect of all the rotational positions of a revolution of the rotor is determined.

49. Measuring method according to claim 38, wherein the time-dependently ascertained measured values for the runout are Fourier-transformed by a computer and in that a frequency spectrum resulting from this is evaluated.
50. Measuring method according to claim 49, wherein an analysis of the frequency spectrum with regard to all the speed-harmonic frequencies is carried out.
51. Measuring method for electric motors, in particular spindle motors, in which the electric motor to be tested is positioned for the measurement on the stator side in a motor mount, and a voltage induced in the non-energized windings of the electric motor with the rotor running freely is measured.
52. Measuring method according to claim 51, wherein the amplitude maxima and zero crossings of the induced voltage influenced by reducing the rotational speed of the rotor are ascertained, and a theoretical profile of the induced voltage is adapted to these values and this adapted theoretical profile is used to ascertain the amplitude values of the induced voltage and zero crossings for an unbraked rotation of the rotor.
53. Measuring method according to claim 52, wherein the variation over time of the amplitude of the induced voltage by means of an envelope curve adapted to amplitude maxima of the induced voltage is sensed.

54. Measuring method according to claim 51, wherein a measured value of the inductance of windings of the electric motor is sensed in respect of each rotational position of the rotor.
55. Measuring method according to claim 51, wherein, in a measuring position with the rotor slowing down and without energizing of the same, a minimum value and a maximum value of the magnetic stray flux at a specifiable location of the rotor is measured.
56. Measuring method according to claim 51, wherein the resistance of the windings of the stationary electric motor is measured.
57. Measuring method according to claim 51, wherein a current fed to the windings with the electric motor running is measured.